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Electrically Tunable Hot-Silicon Terahertz Attenuator[1] MINJIE WANG, Department of Electrical and Computer Engineering, Rice University, ROBERT VAJTAI, PULICKEL AJAYAN, Department of Materials Science and NanoEngineering, Rice University, JUNICHIRO KONO, Department of Electrical and Computer Engineering, Rice University — We have developed a continuously tunable, broadband terahertz attenuator with a transmission tuning range greater than 10^3. Attenuation tuning is achieved electrically, by simply changing the DC voltage applied to a heating wire attached to a bulk silicon wafer, which controls its temperature between room temperature and 550 K, with the corresponding free-carrier density adjusted between 10^{11} cm^{-3} and 10^{17} cm^{-3}. This 'hot-silicon'-based terahertz attenuator works most effectively at 450-550 K (corresponding to a DC voltage variation of only 7 V) and completely shields terahertz radiation above 550 K in a frequency range of 0.1-2.5 THz. Both intrinsic and doped silicon wafers were tested and demonstrated to work well as a continuously tunable attenuator, but they exhibited slightly different behaviors before a dramatic transmission drop at 450-550 K: intrinsic silicon wafers showed a monotonic transmission decrease with temperature while doped wafers showed a slight increase in transmission before the drop. All behaviors can be understood quantitatively via the free-carrier Drude model taking into account thermally activated intrinsic carriers.

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